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The Rural Development Dimension

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1 Introduction

1.1 A short history of the reform of the European Union Common Agricultural Policy

The 1992 CAP reform (Mac Sharry) of the European Union (EU) Common Agricultural Policy (CAP) affected market regulations for cereals, oilseeds, tobacco, milk, beef and lamb (Folmer et al., 1995). The biggest changes occurred in the cereals and beef sector. Minimum cereals prices were decreased by about thirty percent. As compensation cereal growers received subsidies in fixed amounts per hectare. For beef intervention prices were lowered as well, namely 15 percent. Like the cereals sector, the beef producers were compensated by premiums for bulls and suckler cows. Regional reference acreages and herd sizes where installed, which, if exceeded reduce the number of hectares or animals per producer that receive payment.

In March 1999, the EU Heads of Governments and States accepted a further reform of the CAP known as the Agenda 2000 CAP reform. Both internal as external factors called for such a further reform of the EU CAP. Among the internal factors were the possible market imbalances due to continuing yield growth, high internal prices and the corresponding consequences for the EU budget. Moreover, there was an increasing pressure to focus on new priorities of CAP and the desire to create alternative sources of income and employment in rural areas to counteract the decline in the farm population. External factors for further CAP reform where the upcoming negotiations under a new WTO Round and the future enlargement of the EU.

To comply with the principle of budgetary discipline, the Agenda 2000 CAP reform included a further reduction of minimum prices in the cereals, beef and milk sector. This should reduce or completely eliminate the gap and, therefore the need for intervention or export subsidies. Another important element was the alignment of the special regime of oilseeds to that of cereals. In doing so the area payment for cereals increased from € 58.67 per ton to € 63 per ton, while the area payment for oilseeds decreased from € 94.24 per ton to €63 per ton. The basic (compulsory) set-aside was fixed at 10% for all arable

farmers. In the beef sector direct payments increased to compensate the price cuts for both male animals and suckler cows, subject to national ceilings. A new slaughter premium was introduced of € 80 for all the animals over the age of 8 months. The price cuts in the dairy sector were compensated by a subsidy to be paid per ton of quota, based on the quota held by each producer in the 1999/2000 year. Milk quotas were maintained and increased amounting to an overall increase of 2.4% in the EU by the end of the implementation of the reform in 2008. Although the milk quotas were retained the EU committed herself to a review of the quota regime in 2003.

On 26 June 2003, EU farm ministers adopted a further fundamental reform of the Common Agricultural Policy (CAP). The central element of the 2003 CAP reform was the introduction of the single payment scheme (SPS). The SPS is based on payments entitlements linked to eligible land, but decoupled from production. However, to avoid abandonment of production, Member States could still choose to maintain a limited link between subsidy and production under well defined conditions and within clear limits. Moreover, these new "single farm payments" would be linked to environmental, food safety and animal welfare standards and obligations. The idea of the 2003 CAP reform was to make EU farmers more competitive and market orientated, while providing the necessary income stability.

Key elements of the 2003 CAP reform were:

- A single farm payment for EU farmers, independent from production; limited coupled elements may be maintained to avoid abandonment of production;
- land receiving payments should be kept in good agricultural and environmental condition (G.A.E.C). “Good agricultural condition is generally interpreted to mean that the land will not be abandoned and environmental problems such as erosion will be avoided” this requirement could be interpreted as re-establishing the link between the payment and the factors of production employed (land management practices) and ultimately current production; some form of management of the land should be maintained;

- entitlements are tradable within the EU member states (not among them) but certain limitations are imposed (Ciaian, Kancs and Swinnen, 2010). For example, in the Netherlands, entitlements can be transferred among farmers only when the farmer has land without entitlements;
- areas already under permanent pasture must remain so;
- a strengthened rural development policy with more EU money, new measures to promote the environment, quality and animal welfare and to help farmers to meet EU production standards starting in 2005,
- a reduction in direct payments ("modulation") for bigger farms to finance the new rural development policy,
- a mechanism for financial discipline to ensure that the farm budget fixed until 2013 is not overshot,
- revisions to the market policy of the CAP:
    - asymmetric price cuts in the milk sector: The intervention price for butter will be reduced by 25% over four years, which is an additional price cut of 10% compared to Agenda 2000, for skimmed milk powder a 15% reduction over three years, as agreed in Agenda 2000, is retained,
    - reduction of the monthly increments in the cereals sector by half, the current intervention price will be maintained,
    - reforms in the rice, durum wheat, nuts, starch potatoes and dried fodder sectors.

In implementing the SPS, member states (MS) could opt for a historical model (payment entitlements based on individual historical reference amounts per farmer), a regional model (flat rate payment entitlements based on amounts received by farmers in a region in the reference period) or a hybrid model (mix of the two approaches, either in a static or in a dynamic manner). An overview of the implementation of direct payments under the CAP in the different MS can be found at
http://ec.europa.eu/agriculture/markets/sfp/ms_en.pdf.

Denmark, Germany, Luxembourg, Finland, Sweden, England and Northern Ireland

applied a hybrid model. The remaining MS implemented the historical model. From 2007 onwards, dairy payments will be decoupled from production and included in the single payment scheme in all MS.

The MS who joined the EU since 2004 could choose to apply the single area payment scheme (SAPS), a simplified area payment system, for a transitory period until end 2010 or to apply the same system as in the EU-15 immediately. The most important difference between the SPS and the SAPS is that the entitlements under the SPS can be transferred between farms.

Although the intention of the CAP reform 2003 is to decouple payments, some payments were not included. In particular the crop specific payment for protein crops, 60% of the payment for starch potatoes, 42% of the payment for rice, the quality premium for wheat and the area payment for nuts. Market organizations for commodities not included in the reform also remain in place. For sugar this changed by the end of 2005 as a reform of the sugar market was decided upon by the EU ministers of Agriculture. The reform included a reduction of the price levels of sugar and sugar beet with 36%, the introduction of compensation for sugar beet farmers, a premium scheme for the termination of sugar production (what is referred to as the 'restructuring scheme') and the opportunity to purchase quota sugar. The compensation for sugar beet farmers will be included in the single payment scheme.

Until the end of 2007 for several fresh and processed fruit and vegetables coupled payments were given. Since 2008 fruit and vegetables are decoupled and land covered by fruit and vegetables is eligible for payment entitlements under the decoupled aid scheme which applies in other farm sectors (EC, 2007). All existing support for processed fruit and vegetables will be decoupled and the national budgetary ceilings for the SPS will be increased.

The last step of the EU CAP reform dates from 20 November 2008 when EU agriculture ministers reached a political agreement on the Health Check of the CAP. Among a range of measures, the agreement abolishes arable set-aside, increases milk quotas gradually leading up to their abolition in 2015, and converts market intervention into a genuine

safety net (EC, 2009). Ministers also agreed to increase modulation, whereby direct payments to farmers under the SPS are reduced and the money transferred to the Rural Development Fund. This should allow a better response to the new challenges and opportunities faced by European agriculture, including climate change, the need for better water management, the protection of biodiversity, and the production of green energy. Member States will also be able to assist dairy farmers in sensitive regions to adjust to the new market situation.

Under the HC of the CAP it was decided that remaining coupled payments should be decoupled and moved into the Single Payment Scheme (SPS), with the exception of suckler cow, where Member States may maintain current levels of coupled support. Moreover, member states are allowed to review the decision taken on the decoupling of fruit and vegetables in 2007, provided that it results in lower coupled payments. For soft fruits transitional support will continue until 31st December 2011 and be converted into decoupled payment as of 2012 (EC, 2009). Before the HC Member States could retain by sector 10 percent of their national budget ceilings for direct payments for use for environmental measures or improving the quality and marketing of products in that sector (Article 68/69' measures: Assistance to sectors with special problems). Under the HC this possibility will become more flexible. The money will no longer have to be used in the same sector; it may be used to help farmers producing milk, beef, goat and sheep meat and rice in disadvantaged regions or vulnerable types of farming; it may also be used to support risk management measures such as insurance schemes for natural disasters and mutual funds for animal diseases; and countries operating the Single Area Payment Scheme (SAPS) system will become eligible for the scheme (EC, 2009).
Money for Article 68/69' measures increases as currently unspent money can be used for these measures as well. Rural Development money increases as money shifted away from direct aid (modulation) increases to 10% of the direct aid. The funding for Rural Development obtained this way may be used by Member States to reinforce programs in the fields of climate change, renewable energy, water management, biodiversity, innovation linked to the previous four points and for accompanying measures in the dairy sector. This transferred money will be co-financed by the EU at a rate of 75 percent and 90 per-

cent in convergence regions where average GDP is lower. Finally for our purposes it is important to mention that under the HC of the CAP a series of small support schemes will be decoupled and shifted to the SPS from 2012. The energy crop premium will be abolished.

1.2 Objective

From the description of the development of the EU CAP it can be concluded that support went from decoupling from yield, to decoupling from basic crop areas to decoupling from all animals and all eligible crops under the SPS. However, to receive a payment under the SPS, there are many conditions attached to it. Not only should the land be maintained in Good Agricultural and Environmental Condition, but other conditions are in place as well e.g. conversion from grassland to arable land is not possible and trade of payment entitlements without land is only possible to a limited extent. Rural Development payments are also at least partly linked to some kind of agricultural production. Finally, Article 68/69 allows that part of the sector payment based on historical figures can still be paid as coupled payments.

The objectives of this study are the following:

- how and to what extent affect decoupled payments production in agriculture?
- how are the SPS included in economic models that are used in the agricultural policy debate?

To answer the questions above, in chapter 2 we start with a theoretical discussion about the possible effect of decoupled payments on production. In chapter 3 empirical evidence from both the European Community and the United States is discussed. Chapter 4 provides an overview of the way decoupling is implemented in agricultural sector (simulation) models that are used for policy analyses most frequently.

2 Effects of decoupled payments on production: theory

Economic theory suggests that if coupled subsidies are replaced with payments that are totally decoupled from production, production should fall to a level that would exist without subsidies (Hennessy and Thorne, 2005).

Decoupled payments, as defined in the Uruguay Round Agreements Act, are payments that are financed by taxpayers rather then by consumers, are not related to current production, factor use or prices and for which the eligibility criteria are defined by a fixed historical base period, whereby actual production is not needed to receive payments. Decoupled payments are in the World Trade Organization classified as 'green box' or agriculture related subsidies and thus must adhere to the fundamental requirement that the policy has no, or at most minimal trade distorting effects"(Howley at al, 2009).

A large amount of literature is available that analyses the question whether it is theoretically possible to actually decouple direct payments from production (for instance: OECD, 2001a, Jongeneel, 2003; Rude, 2007). From the literature a large number of potential effects of decoupled payments on production are identified:

- liquidity effect (more own money in the pocket to buy intermediates and land)
- creditworthiness effect (cost of access to debt decreases)
- land price effect (aggregate effect of the liquidity effect and the creditworthiness effect)
- risk attitude, resulting in willing to take more risk with investments and expenditures
- expectations effects (future payments can be affected with today's production decisions)
- wealth effect (increase of wealth)
- impact of decoupled payments on the producer decisions to work on the farm and to exit the industry

Given the theoretical arguments, Monge-Arino (2007) concludes that decoupled payments have an impact on agricultural output in case farmers face imperfection in key markets, such as those for financial services and insurance. If the farmer is credit-constrained in that the interest rate on loans is increasing in the debt-to-asset ratio, the decoupled payment decreases the costs of access to debt. A market imperfection also

arises from imperfect information. For example farm lenders follow a rule-based approach to farm foreclosure decisions: they declare bankruptcy if the farm becomes insolvent (i.e., if the equity erodes to zero). This rule reflects an imperfection of the credit market because at the point of insolvency, the expected long-run financial viability of the farmer may still be positive.

Hennessy (1998) argues that if the preferences of farmers are characterized by a decreasing absolute risk aversion (DARA) utility function, uncertainty will have a depressing effect on production. In this case decoupled payments will act as a risk and uncertainty mitigating tool and farmers will expand their production closer to the level they would have chosen in the absence of uncertainty. The conclusion is that "if farmers have DARA preferences and face uncertainty, even the agricultural policies that are designed as lump-sum payments will induce an increase in agricultural output."

In line with reduced uncertainty and more riskier undertakings, Keyzer et al. (2002) argue that decoupling might lead to diversification and more non-agricultural use of agricultural land e.g. through tourism-related activities. Keyzer et al. (2002) also argue that at the level of the sector decoupled payments broadens employment opportunities and therefore it is argued that average labor productivity will increase.

Key and Roberts (2008) develop a household model wherein farmers allocate labor to maximize utility from leisure, consumption and non-pecuniary benefits from farming. These authors find that farmers with decreasing marginal utility of income respond to higher decoupled payments by decreasing off-farm labor and increasing farm labor, resulting in greater agricultural output.

3 Effects of decoupled payments on production: empirical evidence

The SPS in the EU-15 and the SAPS in the EU-10 were only introduced from 2003 onwards. Given limited time series, empirical evidence about the effects of decoupled payments on production is limited. In United States decoupled payments were introduced by the Federal Agriculture Improvement and Reform Act (FAIR) in 1996. Most price-contingent agricultural subsidies were replaced by Production Flexibility Contracts (PFC) or Agricultural Market Transition Act (AMTA-payments). These were lump-sump payments with few relations to farmer's production decisions or in other words fixed, decoupled payments (Key et al, 2005; Goodwin and Mishra, 2005). For more information about the policy of subsidizing agriculture in the US see appendix 2. Below the empirical evidence of production effects of decoupled payments are treated separately for Europe and the United States.

3.1 Empirical evidence from Europe

Hennessy and Thorne (2005) examined the production inducing effects of fully decoupled payments using data on Irish farmer's production decisions.

In Ireland since 2005 all direct payments are fully decoupled. The SFP is based on the historical system. Approximately 600 beef farmers and 170 spring barley producers were surveyed about their production plans for 2007 and 2005 respectively. Based on this survey a multinomial logit model was estimated. The results of this model show that the decision to quit beef production after decoupling is influenced by farm size, operator's off-farm employment status and profitability of the farm. For cereal farmer's none of these were significant relevant for deciding to lower or quit the production.

It was concluded that the decision to continue in production was not explained by the level of the profitability of the farm. It might mean that the decision to continue in production as before is not guided by economic principles but maybe by habit or some other motivations not lead by money. Hennessy and Thorne (2005) compared the results pre-

sented above with an estimation of the profitability of beef and barley production post decoupling. In doing so they conclude that, a significant number of farmers plan to use their decoupled payments to continue or expand economically non-viable production. Notwithstanding these results, it could still be possible that with more time and with generational change, farmers will begin to invest their decoupled payments outside the farm-gate and production in the EU will begin to reflect market conditions.

Keyzer et al. (2002) used CAPMAT to analyze the 2003 CAP reform. They included quite some ad-hoc measures to include different kind of production effects of decoupled payments in general and specific measures to analyze the effects of the 2003 CAP reform. The SPS payments were partly implemented as area premiums and partly as lump-sump transfers. Additional budgetary constraints are included that limit deviations in the premium payments over eligible activities: crops and grassland. The constraints can be interpreted as budgetary flexibility constraints and ensure that the constraints on individual farms (limited possibilities to switch from farm type and technology in the short term) find expression in the national model.

Assumptions are made with respect of:

- the scope of farming activities; more non-agricultural use of agricultural land e.g. through tourism-related activities
- agricultural investments will fall and this affects the growth rate of the livestock sector
- decoupling broadens employment opportunities, and therefore it is assumed that labor productivity will increase

Sckokai and Anton (2005) analyzed whether the change in the type of payments from production driven to (crop) area reduced the link between support and production. The hypothesis is that this change in support type would favor the use of land and reduce the yields. The above mentioned authors tested three sub-hypotheses:

- For the same amount of support in monetary terms, area response to area payments is larger than the area response to price support;
- The impact of area payments on yields is negative;

- The output response on area payments is less than the output response on price support.

These hypotheses are empirically analyzed through the available data (FADN-data) for several EU countries (France, Germany, Italy, Spain and United Kingdom). They used panel data from 1990-2002. So effects of McSharry and Agenda 2000 were included.
The conclusions for these hypotheses are that all three are confirmed but not in all countries for all crops. The main hypothesis is broadly supported by the data. The degree of decoupling varies widely for different commodities and countries. Further econometric studies would be needed to build more robust empirical evidence.

Brady et al (2009) looked at the long term effects of decoupling (2003 Reform) on farm structure, landscape mosaic and biodiversity for a sample of EU regions. In the study they used the AgriPoliS model. AgriPoliS is a spatial, dynamic agent-based simulation model of regional structural change in agriculture (Happe et al., 2006; Kellermann et al., 2008). The principle advantage of AgriPoliS is that it can simulate agricultural development spatially in a region over time (up to 25 years into the future). Brady et al (2009) found that decoupled payments will increase land rental prices and this in turn affects future farm income and production decisions.

Sckokai and Moro (2009) investigated econometrically for crop farms in Italy the long term effects of the SPS, level of intervention prices and area payments on output and investments in machinery and buildings. These authors introduced explicitly farmers' risk attitudes in their dynamic model of farm decision-making. They used data of Italian specialized arable crop farms taken from the EU FADN database for the period 1994-2002. Annually there are about 3.800 individual observations, which results over 9 years in about 34.000 individual observations. For the estimation only data of 15.777 professional farms were used. Using the model they analyzed three scenarios:

1. an increase in the intervention price for cereals
2. an equivalent increase in 'MacSharry-type' area payments
3. an equivalent increase in the Single Farm Payment (SFP)

The first scenario is a shock of the intervention price of 10 per cent. The 10 per cent shock of the intervention prices is only partially transmitted to the expected cereal prices used in the model. In the first scenario the change in expected cereal prices are on average just above 1 per cent. On average the increase in area payments in scenario 2 is 3 per cent, while the increase in farm wealth (defined as the value of farm equity) in scenario 3 is 0.2 per cent. This shows that the SFP remains extremely small relative to the average value of total farm assets. The outcome was that changing intervention prices had a stronger effect on output and investment than changes of the area payment levels or changes of the SFP (Table 1). The relative strong increase in investment and output in scenario 1 is mainly explained by the insurance effect stemming from the increase in the intervention price which reduces price variability and price risks in scenario 1. Policy changes like an increase in area payments or an increase in the SFP do not affect price variability, so the insurance effect is absent and the effects on output and investments are much smaller.

From Table 1 it can be seen that the output and investment effect of the changes in the SFP is small. However, the change in the SFP is also very small. Moreover, the effect of changes of the SFP is different per crop and also dependent on the individual situation of the farmer (farmer's wealth level). As a caveat of their study Sckokai and Moro (2009) mention that their conclusions among other things depend on the assumption that the behavioral parameters estimated with data referring to the pre-reform period are still valid under the new policy environment with the SFP included. Moreover, a very weak link between investment and output was found in the sample used. According to Sckokai and Moro (2009) it is likely that in a different sample a much larger impact of investment and farm output and SFP and farm output might be found.

Table 1. Long-term total effect of three scenarios for the average farm (percentage changes compared to baseline)

	Scenario 1	Scenario 2	Scenario 3
Stock of buildings	0.50	0.08	0.04
Stock of machinery	2.23	0.15	0.01
Maize output	5.58	0.82	0.09
Durum wheat output	-1.12	-0.24	-0.08
Other cereals output	2.20	1.44	0.25
Oilseeds output	1.49	0.42	0.11

Koundouri et al. (2009) observe heterogeneous attitudes with respect of production risk across 100 Finnish cereal FADN farmers and across years (1992-2003). They find that through their effect on income, the decoupled payments make farmers less averse towards production risk which in turn affect production through choice of crop mix and input use. Table 2 shows some selected results of policy simulations with the estimated model. It is found that direct farm payments slightly decreases the use of fertilizer, but it increases the use of labour and plant protection. Due to changes in input-mix and land allocation the total production of wheat and barley decreases slightly. Given the rather extreme policy shock the impact of decoupled direct farm payments on input use and production should be considered as limited, with the impact on the use of plant protection as the exemption. Koundouri et al. (2009) also note some caveats of their study. Among other things they do not take into account other types of risk as e.g. price risk. Results from studies that focus on only production risk or only price risk, may not hold if both output price and production uncertainty are present. In fact, these uncertainties may have opposite impacts on the input use (Koundouri et al., 2009).

Table 2. Simulated impact of direct farm payments on input use, land allocation and production for the average farm (percentage change relative to the absence of subsidies)

	Subsidie (€/ha)	Fertilization	Labour	Plant protection	Share of land in wheat	Production
Area subsidized	€628 (wheat) €532 (barley)	-5.0	1.4	108.9	-1.4	-3.0
Single farm payment	€532	-2.0	0.7	56.8	-0.2	-1.6

Source: Koundouri et al. (2009)

Courleux et al (2008) examined how the SPS could be implemented the best in empirical models. They conclude that "since the SPS does not build on a zero support regime but inherits from the previous 1992-1999 reforms, SFP entitlements should therefore not be modeled as lump-sump transfers". And also: "the 'coupling factor'[1] strategy appears to be a suitable solution". For latest conclusion however it should be notified that calibrating the decoupling factor is a difficult task.

3.2 Empirical evidence from the United States

Bhaskar and Beghin (2009) provide an excellent literature review on (mainly) econometric applications estimating the effect of decoupled farm payments on production. They distinguish five main mechanisms how decoupled payments may influence farmers' production decisions[2]: (1) their effect on farmers' risk attitude, either by reducing their level of risk aversion (wealth effect) or by reducing the risk they face (insurance effect), (2)

[1] Decoupling strategy is for instance described Courleux (2008) "In order to account for the fact that supply-inducing effects of area payments are less than the impacts of output price support area payments (or other payments for animals) are multiplied with a coupling factor".

[2] The mechanisms mainly comply with the effects discussed in Chapter 2.

their effect on access to credits, (3) their effect on labor allocation decisions of farm households, (4) their effect on land values, rents, and land prices, and (5) their effect on farmers' decisions through expectations about future payments. They also found studies analyzing the effect of decoupled payments on entry and exit decisions of farmers and on the environment by influencing input usage. Bhaskar and Beghin (2009) conclude that decoupled payments are not fully decoupled as they influence farmers decisions through the channels identified above. However, in most studies the magnitude of these impacts was found to be small. The exception is with respect to land markets. Decoupled payments tend to be capitalized into higher land values which increase land rents and prices. "This feature could lead to land remaining in agricultural use rather than being converted into non agrarian alternate uses" (Bhaskar and Beghin, 2009). It is also concluded that wealth effects are positive but small in magnitude. Insurance effects are more important than wealth effects in determining the impact of decoupled payments. If decoupled payments vary by crops and if come crops are not eligible to receive payments, they also influence crop choice. Finally Bhaskar and Beghin (2009) note that the cumulative impact of the individual effects should be analyzed further.

Burfisher and Hopkins (2003) worked on the analysis of farm household survey data. Their study indicates that U.S. decoupled payments have increased the level of overall well-being of households that receive payments by Production Flexibility Contracts (PFC- payments), where well-being is defined broadly to encompass income, wealth, and consumption as well as how people choose to spend their time. The average PFC payment equaled about € 30 per ha. The payments have also led to small reductions in households' work hours, including their on farm labor. PFC recipients were also found to allocate a large share of their investments to assets unrelated to agricultural production. This indicates that nonfarm investments are likely to play an important role in their allocation of savings from PFC payments as well as in their adjustments to any changes in risk attitudes attributable to the payments. In addition, aggregate data on investment by participating households show no evidence of higher rates of on farm investment or capital replacement compared with nonparticipant households. These findings, together with the results of a simulation of a U.S. decoupled payments program, indicate that the PFC

cash payments changed and increased recipients' well-being but in ways that can be expected to have minimal links to farm production levels. The main impact of decoupled payments is likely on land values. These were shown to have increased about 8 percent due to the payments.

Key et al. (2005) studied the effect of large-scale U.S. federal agricultural programs by comparing program participants with non-participants. Both groups were similar in their observed characteristics. The results (to be interpreted as preliminary) indicate that participants increased plantings of program crops considerably comparing with non – participants. There was also a difference in the growing of the farm size and total sales.

Key and Roberts (2008) examined the effect of decoupled payments on the acreage response of Iowa farmers who were in business in 1997 and 2002. They used farm-level panel data from the U.S. Agricultural Census. They compared farmers receiving high levels of payments per hectare with farmers who didn't in relation with increase in program crop area. The conclusion was that there are small but significant farm level effects of the decoupled payments on production.

Dewbre et al. (2001) used the policy evaluation matrix (PEM) model to analyze the transfer efficiency and trade effects of direct payments. PEM is used to support ongoing monitoring and evaluation of Member country agricultural policies using the PSE (OECD, 2001b). PEM comprises of six individual country modules: Canada, the European Union (treated as one country), Mexico, Switzerland, and the United States, and one for the rest of the world. Using this framework Dewbre et al. (2001) showed that payments based on land use are by far the type of support that causes the smallest distortion on production and trade while at the same time being most efficient in providing income benefits to farm households. Income transfer efficiency is defined as the ratio of income gains of the targeted beneficiaries to the sum of the associated government expenditures and consumer costs. Another finding is that with less strings attached to the decoupled payments, the more efficient and less production and trade distorting the payment is. Hence it is concluded that policy can reduce distortions to agricultural production and trade while simultaneously increase the benefit-cost ratio of the support policies.

Adams et al. (2001) conclude that the impact of PFC on area planted is positive, significant but modest: an increase of less than 0.3% in total area planted can be expected if PFC (production flexibility contracts) and Market Loss Assistance payments increase by 10 percent.[3]

Burfisher and Hopkins (2003) conclude that the effects of decoupled payments on planted acreage are smaller than those stemming from price-linked and production-linked coupled programs. Although farmers are generally risk averse, there also appears to be a wide range of risk attitudes. Thus although no program appears to be completely without potential effects on agricultural production, the effects of decoupled programs are argued to be small:

- payments are low compared to the recipients wealth
- farm production is only one of the multiple instruments that farmers use to take on additional risk
- changes in risk attitudes, stemming from the decoupled payment, can also include adjustments throughout the farmers' portfolio towards non-farm investment.

Anton (2005) concludes that the wealth effects associated with reduced risk preferences, as well as other indirect effects are minimal in terms of their potential to affect production decisions.

Chau and de Gorter (2005) found (by using a model calibrated with the production and cost structure of the U.S. wheat sector), for the wheat sector in the USA that in the absence of decoupled payments the number of farms will fall, but not as much as a coupled subsidy were to be removed. Farms that are likely to exit are low-profit ones. This implies that the impact of the removal on output and exports remain quite limited. This research was based on a generalized theoretical model of cross-subsidization (developed during the study) and an empirical example calibrating the production and cost structure of the U.S. wheat sector.

[3] In this case the sum of the PFC and MLA payments were in between 10/45$ per acre (25/111 $ per ha) depending on state and year. The market/loan payment was in between 175/250$ per acre also depending on state and year.

4 Application in different types of models

"the way in which the single farm payment is implemented and modeled may notably influence producer decisions and the projected production patterns" Bascou et al., (2004)**.**
In this chapter several partial and general equilibrium models that are most used in the agricultural policy debate will be discussed shortly. Next we focus on the way the SPS is taken into account. A short overview of models and owners is shown in appendix 3.

4.1 ESIM

The model

ESIM (European Simulation Model) is a recursive dynamic partial equilibrium model with lagged price responses at the supply side (Balkhausen and Banse, 2006). The model covers 36 products plus voluntary set-aside area and 29 regions. World mark prices are endogenous. The model focuses on the EU with detailed formulation of agricultural policies in the 15 EU-member states as well as the New Member States (NMS) and the EU-accession candidates. In ESIM area is allocated as a function of current own and cross-prices, direct payments and labour and capital cost indices (Balkhausen et al, 2008).

Recently the model has been extended in order to be able to model country specific options of implementing the decoupling regulations at country level.

Implementing decoupled measures

Direct payments enter the allocation functions in the same way as prices: that is, market price and direct payment per product unit make up an incentive price, which is the explaining variable. The calculation of the level of direct payments depends on the country and the policy applied.

In ESIM direct payments are added to the producer prices and together they form the Producer Incentive price. These prices are used in equations like the shadow prices for crops, livestock and set aside. Direct payments can be divided into direct coupled payments and decoupled payments. Direct coupled payments do count for cereals, oilseed,

rice, livestock and set aside. Direct payments for crop and animal products are determined per ton of output. They are calculated as the premia in euro multiplied by the exchange rate of the individual member state and the phasing coefficient which takes the stepwise introduction of the direct payments in the NMS into account.

Decoupled payments are calculated for all other crops with a difference in calculation for EU-15 members and new member states. They are calculated as the premium in euro multiplied by the exchange rate of the individual member state's exchange rates for those countries applying the SFP's and the SAP's (Banse et al, 2004).

So you might conclude that decoupled payments in ESIM are generally modeled as a uniform regionalized payment per ha independent for which type of SPS a member state has opted. The 'decoupling factor strategy' is used and the degree to which decoupled payments affect production can be different per crop and animal and per country (Balkhausen et al, 2008: table 4).

4.2 LEITAP

The model

LEITAP is a global computable general equilibrium model that covers the whole economy including factor markets (Meijl, et al., 2006; Nowicki et al., 2009). More specifically, LEITAP is a modified version of the global general equilibrium Global Trade Analysis Project (GTAP) model (Hertel and Tsigas, 1997). Agricultural policies are treated explicitly (e.g. production quotas, intervention prices, tariff rate quotas, (de)coupled payments). Information is used from the OECD's Policy Evaluation Model (PEM) to improve the production structure and a new land allocation method, that takes into account the variation of substitutability between different types of land, as well as a new land supply curve have been introduced. LEITAP has been extended to include a recursive dynamic version with endogenous technological change by specifying a relation between investments and productivity change.

Implementing decoupled measures

In LEITAP decoupled direct payments are modeled as payments linked to land. It is assumed that land in all agricultural sectors that are eligible for single farm payments receives the same payment rate. Therefore, the payment has no effect on the choice between eligible crops within agriculture. However, in this economy-wide model the payment favors agricultural sectors relative to manufacturing and service sectors; this is called the general equilibrium (GE) effect. Due to the payments, farm income increases and more production factors stay within the agricultural sector. And thus, for example, land abandonment is less (Nowicki et al, 2007).

4.3 AGMEMOD

The model

AGMEMOD consists of country models covering about 75 percent of the agricultural output of the EU27 because not all products are taken into account. The model is constructed by country project teams, covering all EU member states, which are members of the AGMEMOD Partnership. They have built compatible models for their own countries. The AGMEMOD Partnership model is an econometric, dynamic, multi-product partial equilibrium model that allows making projections and simulations in order to evaluate measures, program's and policies at the European Union level as well as at the Member States level.

The commodity coverage of the current version of the model extends to markets for grains (soft and durum wheat, barley and maize), oilseeds (rapeseed, soybeans and sunflower seed) and to the markets for their associated meals and oils, root crops (sugar beet, sugar and potatoes), livestock (cattle, pigs, poultry, and sheep), milk and dairy products (cheese, butter, whole milk powder and skim milk powder), apples, oranges, tobacco and cotton. Most of the equations in the model have been estimated using annual data over the period 1973-2005/06/07 (depending on the country), or over shorter periods in case data were not available (such as for the new member states). The annual data were ob-

tained from Eurostat's NewCronos database, Oil World, OECD databases, FAPRI forecasts and from Member States' agriculture ministries (www.tnet.teagasc.ie/agmemod/).

Implementing decoupled measures

AGMEMOD contains a harmonized policy modelling approach meaning that part of the decoupling effect is regarded as a market effect in order to induce a farmers' response. All types of direct payments related to the different sub-sectors are included in the form of price policy add-ups. These add-ups increase the margin between the producer price and input costs. The policy price add-ups constitute the reaction price that is used to assess the impact of the total support on agriculture. Together with certain coefficients – multipliers – the reaction price accounts for the decoupling effect of direct payments. The multipliers adjust the size of support in the reaction price for livestock products and in the expected gross return per hectare for crop products. The multipliers vary depending on whether the payments are based on the historical or the regional model. Multipliers applied for decoupled regional or historical payments lie between 0 and 1 (Chantreuill et al., 2010).

4.4 FAPRI

The model

FAPRI stands for Food and Agriculture Policy Research (organization). They developed a set of non-spatial partial equilibrium models for major agricultural markets. (http://www.fapri.iastate.edu/models/). The models are:

- Crop Insurance

  The FAPRI Crop Insurance Model examines and projects the coverage, usage, performance, and expenditures for the U.S. crop insurance program.
- Dairy

  The FAPRI International Dairy Model examines and projects the area, production, usage, stocks, prices, and trade for fluid milk, butter, cheese,

nonfat dry milk, and whole milk powder for several countries and regions of the world.

- Grains

  The FAPRI International Grains Model examines and projects the area, production, usage, stocks, prices, and trade for wheat, corn, barley, and sorghum for several countries and regions of the world.

- Livestock

  The FAPRI International Livestock Model examines and projects the area, production, usage, stocks, prices, and trade for beef and veal, pork, and poultry meat for several countries and regions of the world.

- Oilseeds

  The FAPRI International Oilseeds Model examines and projects the area, production, usage, stocks, prices, and trade in the soybean, rapeseed, sunflower seed, palm, and peanut complexes for several countries and regions of the world.

- Sugar

  The FAPRI International Sugar Model examines and projects the area, production, usage, stocks, prices, and trade for sugar for several countries and regions of the world.

- FAPRI uses comprehensive data and computer modeling systems to analyze the complex economic interrelationships of the food and agriculture industry.

- FAPRI-Iowa State University maintains the international modeling structure for grains, oilseeds, livestock, dairy, and sugar and U.S. crop insurance model. FAPRI-Missouri maintains the U.S. modeling structure for grains, oilseeds, livestock, and dairy, along with models for the international cotton sector and the European Union.

FAPRI-EU

The EU-component of the basic FAPRI-model treats the European Union (27 MS) as a bloc. The EU portions of the model generally follow the structure described above.

Recently a new experimental model for the EU-agricultural sector has been build. It follows the same structure as mentioned before but it provides country-level detail for France, Germany, Italy and the United Kingdom (FAPRI Gold model). The Gold model (grains, oilseeds, livestock and dairy) is maintained at the University of Missouri and developed with the FAPRI-Ireland and FAPRI-UK partnerships.

The EU-Gold model is a dynamic partial equilibrium model of the agricultural sector and is a look alike of the models that FAPRI has used for many years. The EU-Gold model includes the main commodities that are supported in the EU (DG-Agri, 2000 and Binfield et al, 2004).

Data for the model mainly comes from EUROSTAT (New Cronos) and the USDA (production, supply and demand).

The model is arranged as a system of single equations for the production, demand and trade for each of the commodities. For most equations the behavioral parameters have not been estimated but are derived from behavioral parameters taken from the literature or imposed on expert judgment (Binfield et al, 2004).

Implementing decoupled measures

In FAPRI-GOLD the coupling factor strategy is used to implement the SPS. In the FAPRI-GOLD model a value of 0.3 was chosen – which implies that one euro spent as part of the SFP has 30 per cent of the impact of the area payments under Agenda 2000[4]. This means that one euro of SFP is assumed to have the same impact on production as 0.3 euro of coupled payments (Binfield at al, 2004). This 0.3 is chosen to be consistent with the US model which had provided reliable in projections of both baseline values and when used in policy simulation. In the FAPRI Gold model the new payment system is modeled as follows:

A = SFP payment

B = Re-coupled Agenda 2000 payment

C = new coupled payment

4 Binfield et al. (2005) assume that the production effect of area payments under the Agenda 2000 reform equal 50% of a proportionate increase in market receipts.

x = decoupling coefficient

m = 1-modulation rate

s = stocking density

Historic = (A* x + B)* m + C

Where A = old payment not re-coupled

Regional Crops = (A* x+ B) * m + C

Regional Livestock = (A * x * s+B)*m+C

(for both A = total payment/area or new payment).

In FAPRI the crop model interacts with the livestock sector through feed demand relationships. The GOLD model does not include area that is devoted to livestock production in the area allocation system.

4.5 CAPRI

The model

CAPRI is a partial equilibrium model for the agricultural sector developed for policy impact assessment of the Common Agricultural Policy and trade policies from global to regional scale (NUTS II level) with a focus on the EU.

The model is a comparative partial static equilibrium model, solved by iterating supply and market modules

- Supply module: the supply module comprises about 50 crop and animal activities for each of the around 280 regions (at the so-called NUTS-2 level covering EU27, Norway, Western Balkans and Turkey), and includes about 50 inputs and outputs. Each independent model optimizes regional agricultural income at given prices and subsidies, subject to constraints on land, policy variables and feed und plant nutrient requirements in each region.
- Market module: the CAPRI global market model is a comparative static Multi-Commodity model. It covers 47 primary and secondary agricultural products. Product quantities are expressed in physical primary product equivalent according

to the concept of Supply Utilization Accounts of FAO. The global market is a square system of equations without an objective function. Its equations may be interpreted as the first order conditions from simultaneously maximizing globally producers' and consumer's rents in competitive international agricultural markets at given non-agricultural prices (primary factors, agricultural inputs and any other produces) and income.

- Equilibrium ensures cleared markets for products and young animals, match of feeding requirements of national herd (source: www.capri-model.org).

Implementing decoupled measures

The decoupled payments in CAPRI are modelled as a direct payment linked to land, but where the amount paid is the same regardless of how the land is used, as long as it is not completely abandoned. Thus, the payment has the effect of increasing land rents (compared to no policy), increasing agricultural income and of preventing land abandonment, but has no effect on the choice between eligible crops.

In effect the SPS payment rates are computed in two steps: First, the total payment per Nuts 2 region is calculated (for the historical reference year) taking into account payment ceilings, national coupling options and the choices made regarding the implementation of the single farm payment (for example regional flat rate, hybrid model, single area payment and/or article 69 choices). The total regional payment is then divided by the regional eligible area to obtain the average SPS amount per hectare in each region, with the total regional amount as the payment ceiling. This approach means that it is possible to capture regional differences in payment rates (Renwick et al., 2008). Moreover, it seems that CAPRI is the only model that tries to take into account the different implementations of the SPS (SAPS, farm payment schemes, regional implementation, hybrid schemes, etc.) in the different countries of the EU-27 explicitly.

With this implementation, the “decoupled” payments are not fully decoupled in CAPRI, but have a small general production effect. Nevertheless, the degree of coupling is small compared to the “coupled” payments and is not crop specific. However, in Nowicki et al. (2009) it is explicitly noted that theoretical production effects as e.g. wealth and insur-

ance effects are not modeled, and neither is the potential effect on farm viability, since neither risk nor single farms are explicitly modeled in CAPRI.

4.6 AGLINK

The model

AGLINK is a partial equilibrium model of the agricultural sector that represents the most important markets in the world agriculture. It consists of 10 fully-fledged country-modules plus a rest of the world. The EU is treated as one country-block, just like the USA. AGLINK includes over thirty of the most important products in terms of output and trade in the OECD area (Conforti and Londero, 2001).

Like other main partial equilibrium global models, AGLINK consists of a set of behavioral equations, technical relations and a set of identities that model the relations among the agricultural activities and between agriculture and the rest of the economy.

AGLINK assumes perfect competition in all markets and perfect homogeneity for products from different countries.

Implementing decoupled measures

For a study of the effects of the CAP 2003 reform, AGLINK has been adapted to the new defined EU Agricultural policies (OECD, 2004). We will discuss here the area payments (for crops) which already where introduced since 2000 and Single Farm Payments for crops and beef production.

Payments are used in the crop area and beef production equations. For area payments and the SFP, production ratios are estimated using the PEM for crops. They compare the relative production impact of area payments and payments based on historical entitlement with the impact of equivalent amounts of market price support. The methodology is described in Dewbre et al. (2001). These ratios are applied to the different categories of payments in the relevant AGLINK crop and livestock equations. PEM does not contain

the beef sector and therefore the same ratio is used for the SFP in the beef production equations.

Crops

Area payments

The area payments for cereals and oilseeds remain. These payments enter together with average crop returns the allocation equation for total area devoted to cereals and oilseeds. As these payments are supposed to have less impact on production than market returns, the payments are weighted with a production ratio X derived from Dewbre et al. (2001).

Single farm payments

Most of the payments for crops will become part of the SFP. The area payment for cereals, oilseeds and rice will remain an area payment. These area payments for cereals and oilseeds, together with the average crop returns enter the allocation equation for total area devoted for cereals and oilseeds. As these payments are known to have less impact on production than market returns, payments are weighted with a production ratio.

Beef production

Part of the headage payments for beef producers is not changed due to the CAP reform 2003. Other headage payments for beef producers are reduced or abolished and become part of the SFP partly depending on further decisions by Member Countries.

Single farm payments

"The levels of the different headage payments are currently calculated endogenously in the model, using marginal producer decision making. These payments are there after incorporated as an equivalent price gap in the inventory and production equations. The SFP introduced in 2005 affects production decisions on all eligible farming activities. In the beef production equation, the SFP therefore replaces part of the total of the coupled headage payments in the above specified equations. The SFP per head is equal to the SFP per

hectare of eligible land divided by the weighted average stocking density in the baseline, taken into account the average carcass weight of each category of animals (beef, veal, and sheep). As in the land equation a lower production ratio of 0.06 is used for the SFP."

Area decisions and the land market

Von Lampe (2010): "decoupled" payments are modeled to affect area decisions as all payment at least have wealth- and risk effects, both increasing the incentives to expand crop areas. However, no such clear-cut link can be seen for yields, which is why we model crop yields as independent of such payments. Note however that output-based payments obviously do change yields". Von Lampe in Balkhausen et al (2008) mentioned that in AGLINK area allocation depends on own and cross commodity gross market returns as well as on direct payments adjusted by a factor between 0 and 1 reflecting de degree of "coupledness' of the payment.

In AGLINK modeled land use is scaled to the total land available.

4.7 PEM

The model

The PEM model is a comparative static simulation model of the crop and dairy sectors comprising six country modules with the EU treated as one module and a "rest of the world" module. The model does neither represent individual countries nor all agricultural sectors. Currently the PEM contains representations of demand and supply of wheat, coarse grains like (maize, barley and oats), oilseeds, rice and milk. This includes implicit production functions and market clearing for a set of production factors (OECD, 2004).

The main purpose of the PEM is to provide a closer connection between measurement of support as defined for the Producer Support Estimate (PSE) and quantitative analysis of the impacts and distribution of such support (GTAP, 2006)

Implementing decoupled measures

Martini (2010):"For each payment considered more decoupled from production, the scope of it's application is defined according to what land uses qualify for the payment. The payment is then constructed to provide a uniform inflation with respect to the supply price of each land use, ensuring that the payment does not provoke any relative price effects in the land market for permitted uses. While net land supply for the whole agricultural sector in PEM is inelastic, the net elasticity of the subsets of land which receive decoupled payments is greater than zero, how much so depends on the proportion of total land to which the policy applies. In general the payment provokes a relative price effect in the land market between permitted and excluded uses of land and a relative price effect between land and non land inputs. These effects are typically small relative to more coupled policies but can be significant depending on the scope and size of the payment.

4.8 DRAM

The model

DRAM has been developed as an activity-based, comparative static, partial equilibrium, regionalized mathematical programming model of Dutch agriculture (Helming, 2005; Helming and Reinhard, 2009). Its focus lies on modeling the allocation of fixed-factor inputs to different agricultural products and on the formation of manure and agricultural land market prices at regional level. The allocation of fixed-factor inputs across regional agricultural activities is based on profit maximization across the activities under given technical and institutional restrictions (market, environmental, and agricultural policies).

Interactions between different agricultural activities through the joint use of fixed-factor inputs have been taken into account. Fixed-factor inputs are land, production quotas, and the manure application room (defined as the fields available to apply manure upon multiplied by the nutrients from manure application standards per hectare). Regional land balances model the total amount of agricultural land available in a region. Regional shadow prices of animal manure result from the regional balances of supply and demand of ani-

mal manure. These manure balances include transport of animal manure to other regions in the Netherlands and exports and imports from abroad.

The model is flexible to choose between 12 provinces or 66 agricultural regions. The model is based on 35 activities. These activities can be divided between 20 crop activities (soft wheat, rye, barley, oats, granule, other cereals, oil crops, legumes, sugar beets, other arable crops, fodder maize, grassland, other fodder crops, vegetables (arable), seed potatoes, consumption potatoes, starch potatoes, seeds, other arable crops and green manuring) and 15 livestock activities (female beef cattle, male beef cattle, meat calves, fattening pigs, sows, meat poultry, laying hens and eight types of dairy cow activities). Note that the model can choose between 8 types of dairy cow activities to fully produce the regional milk quota. It is assumed that they represent 8 types of specialized dairy farms in the Netherlands (Table 3). The activities in DRAM can be grouped into activities that are directly linked to land and activities that are only indirectly linked to land, through the roughage balance and/or through the use of regional or national manure application room. Crop and dairy cow activities belong to the former category and remaining livestock activities belong to the latter category. Hectare of grass and maize per head per type of dairy cow are fixed in DRAM. So, the dairy cows are directly linked to land. In DRAM the total hectare of grassland is endogenously determined by the hectare of grassland directly linked to the dairy cows plus the hectare of grassland not (directly) linked to the dairy cows (part of the set crop, mentioned above). In the same way the total hectare of fodder maize is modeled.

Table 3: Type of dairy farms represented by the dairy cow activities included in DRAM

Type of dairy farm (in this report)	Type of dairy farm in DRAM	Milk production (kg per dairy cow)	Dairy cows (heads per hectare)	Dairy cows (heads per farm)
Small and extensive dairy farm	dairy 1	< 7450	< 1.6	< 60
	dairy 3	< 7450	> 1.6	< 60
Small and intensive dairy farm	dairy 5	> 7450	< 1.6	< 60
	dairy 7	> 7450	> 1.6	< 60
Large and extensive dairy farm	dairy 2	< 7450	< 1.6	> 60
	dairy 6	> 7450	< 1.6	> 60
Large and intensive dairy farm	dairy 4	< 7450	> 1.6	> 60
	dairy 8	> 7450	> 1.6	> 60

Implementing decoupled measures

Different types of historical and coupled payments or premiums are included in DRAM: animal premiums, extensification premiums, slaughter premiums, milk premiums and hectare premiums. These premiums are linked to activities and regions. To calibrate Single Farm Payments stemming from the CAP Reform 2003 for some base period, we distinguish between decoupled payments and coupled payments (e.g. part of the payment for starch potatoes and slaughter premiums of different type of cattle that where still coupled to production after the CAP Reform 2003) per activity.

Next, the individual activities are linked to 10 types of farms: 1 type of arable farm, 8 types of dairy farms and 1 remaining farm type. To clarify this, the arable crop activities represent all arable farms, the 8 type of dairy cows represent 8 type of dairy farms and the remaining activities (remaining grassland and fodder maize (that are grassland and fodder maize not linked to dairy cows), female beef cattle, male beef cattle, meat calves, fatten-

ing pigs, sows, meat poultry and laying hens) represent all other farms. The different types of farms are also referred to as land use classes.

Next, total decoupled payment per type of farm or land use class is calculated by the decoupled payment per activity times the number of activities summed over the activities per type of farm or land use class. In the same way, total acreage of eligible crops per type of farm or land use class is calculated by the hectare per eligible activity times the number of activities summed over the activities per type of farm. Next, the average decoupled payment per hectare per land use class is calculated by dividing the total decoupled payment per type of land use class by the total acreage of eligible crops per land use class. Next, the per hectare direct payment per land use class is linked back to the corresponding land using activities. In practice this means for example that the average decoupled direct payment per hectare of land use class "fodder maize and grassland, not directly linked to dairy cows" is linked back to the individual activities grassland not directly linked to dairy cows and fodder maize not directly linked to dairy cows.

Table 4: Average decoupled farm payment in the Netherlands by type of activity (€ per ha)

Land use classes	Payment (€ per ha)
Dairy 1	353
Dairy 2	365
Dairy 3	437
Dairy 4	510
Dairy 5	464
Dairy 6	431
Dairy 7	603
Dairy 8	631
All arable crop activities[1]	313
Grassland and fodder maize, not directly linked to the dairy cows	178

1. All arable crops are assumed eligible to receive the farm payment

Table 4 gives the national average decoupled farm payment per hectare per land use class, based on historical payments and including the decoupled part of the payment for starch potatoes and sugar beet premiums, excluding the coupled part of the payment for starch potatoes and the slaughter premiums for dairy cows, beef cattle and fattening calves. The national average payment for land use classes linked to the dairy cow activities differ between € 631 per ha for type dairy 8 to € 353 per ha for type dairy 1. Differences are explained by the differences in milk production per hectare in the base period. The farm payments for the dairy farms are well above the national average farm payment per hectare of arable crop and far above the average payment per hectare for remaining grassland and fodder maize.

4.9 DREMFIA

The model

DREMFIA is a dynamic regional sector model for Finnish agriculture. It includes 17 production regions, endogenous investments, and technical change. Recursive programming is used in simulating annual market reactions and economic adjustments. The model consists of two main parts: (1) a technology diffusion model determining sector level investments in different production technologies; and (2) an optimization routine simulating annual price changes by maximizing producer and consumer surplus subject to regional product balance and resource constraints (Lehtonen, 2004).

Implementing decoupled measures

If payments earlier paid per animal or hectare of crop, or quantity produced (milk in Finland) become decoupled it means that the payment becomes a part of the CAP single farm payment paid per hectare of farmland, irrespective of crop. In other words, all crop activities and set-aside land (not open set-aside i.e. set-aside without any vegetation cover) are eligible for decoupled payments in Finland. However, an important detail of the national implementation of the CAP reform in Finland is that in the case of set-aside,

the land must be established as grasslands, to decrease environmental risks; hence open set-aside is not eligible for the CAP single farm payment (Lehtonen, 2010). The quantity or head specific payments have impacts already in the technology diffusion module - with dynamic influence on animal places available (and subsequent market behavior) - not only in the market module of DREMFIA. According to Lehtonen (2010), compared to other models which consider decoupled payments explicitly in the market model, this is in fact the value added of the DREMFIA approach or any other approach which includes investments and endogenous structural change. The decoupled payments are modeled as per hectare payment no matter of production (Lehtonen et al., 2007, p. 427).

4.10 RAUMIS

The model

RAUMIS is a comparative-static model representing the German agricultural sector. In total 326 regions (Landkreise) at NUTS III level are modeled. Assuming profit maximizing behavior of the farms, the optimal production structure in a region is modeled applying Positive Mathematical Programming (PMP) (Goemann et al., 200x).

Implementing decoupled measures

Since Germany opted for the regional model, policy changes made in the Health Check are largely not relevant for modeling decoupled measures in Germany. It is assumed that the volume of direct payments will stay approximately the same also after 2013 (Goemann et al., 2010). The now valid baseline until 2019 is updated with values of the German Ministry of Agriculture (BMELV) (Kreins, 2010). The decoupled measures are implemented as follows:

Gelöscht: 09

1) The amount of premiums (for direct payments) and the estimated total payments at regional (Bundeslander) level are received from the German Ministry of Agriculture (BMELV). These are allocated according to arable and grassland resulting in an average premium per acreage for each Bundesland. In the model, each crop which is entitled to a premium receives a corresponding payment.

2) The allocation of subsidies of the second pillar refers to the subsidy allocation in the past. The amount of subsidies varies according to political decisions (Kreins, 2010).

4.11 AROPAj

The model

The mathematical programming model AROPAj is based on farm groups. It consists of a set of independent, mixed integer and linear programming models. Each model describes the annual supply choice of a given farm group. The primary source of data is the Farm Accountancy Data Network (FADN). The model covers 101 FADN regions of the EU15. It includes all farms represented in FADN apart from the specializations "horticulture" and "permanent crops" (Debove and Jayet, 2006).

Implementing decoupled measures

The decoupling reform as modeled with AROPAj is subject to the structure of the model, based on FADN regions and farm groups. Based on the FADN data, it is possible to compute single farm payments for each farm group or unique regional entitlement. According to Chakir et al. (2007), the computation of individual or regional decoupled payments in the AROPAj model is based on the Agenda 2000 policy. Two runs of the model are necessary to take into account decoupling. In the first run the decoupled payments are computed (varying according to the level of set-aside and national legislation) and in the second run the effects on production and revenues are measured (Chakir et al., 2007).
In order to implement the decoupling into the model, a matrix establishing new parameters (*refarea*, *psngl*, *reffin*), new activities (X_{nsa}, X_{sgdl}, X_{pgdl}, X_{rgdl}, I_{gdlg}, I_{gdlh}) and new constraints (GDL_i with $1 \leq i \leq 6$, *GDU*) is introduced into the code (Table 55).

Table 5. Technical introduction of the decoupling scheme and related set-aside in the AROPAj model

	X_{nsa}	X_{pas}	X_{sgdl}	X_{rgdl}	X_{pgdl}	I_{gdlg}	I_{gdlh}	ZF	
OBJ	psgel			psngl+psrta	Psngl+psrpa				
GDL_1	-1					refarea			≤ 0
GDL_2			1				-99999		
GDL_3				1	1	-99999			≤ 0
GDL_4	1							-reffin	≤ 0
GDL_5	1		1	1	1			-SAU	≤ 0
GDL_6		-1			1				≤ 0
GDU						1	1		= 1

Source: Debove and Jayet, 2006.

Parameters:

Refarea set-aside area of the reference period

psngl per hectare premium computed in the first run of the model as SFP

reffin amount of support received for set-aside during the reference period (the set-aside supported cannot be larger than *reffin*)

Activities:

X_{nsa} set-aside area which is supported as of the first ha and which can vary from 0 to *refarea*

X_{sgdl} area that receives no support (if X_{nsa} is less than *refarea*)

Since Germany distinguishes between pasture and arable land which do not receive the same support, X_{pas} and X_{pgdl} are introduced which represent the pasture activity in the model.

X_{pas} implicates agricultural costs and all constraints related to technical modules (i.e.

the agronomic and the feed-related module)

X_{pgdl} implicates the decoupled payment

The line "GDU" represents the exclusion constraint on the binary variables I_{gdlg} and I_{gdlh}. If I_{gdlg} = 1, farmers receive payments for the total farming area, if I_{gdlh} = 1 payments are only received for a part of the area.

Other variables:

psgel set-aside payment

psrta arable land payment (valid for Germany, for other Member States *psrta* = *psrpa* = 0)

psrp pasture payment (valid for Germany, for other Member States *psrta* = *psrpa* = 0)

SAU whole surface to be shared between variables X_{nsa}, X_{sgdl}, X_{rgdl} and X_{pgdl}

ZF right hand side column

Different decoupling factors are introduced for each land and each activity.

4.12 SEPALE

The model

The agricultural sector model SEPALE is developed by the Université Catholique de Louvain, the University of Ghent and the Centre for Agricultural Economics of the Ministry of the Flemish Community. Based on economic and production theoretic assumptions of farmer's behaviour and the representative sample of the FADN farms, the model simulates the agro-economic and environmental consequences of specific policy decisions at the level of the farm. With respect to specific policies, farms can be selected by farm size, region and farm type. The agricultural sector model SEPALE relies on Positive Mathematical Programming (PMP) and optimizes at farm level, with opportunities to simulate exchange of intermediates, production factors and production rights. Based on the FADN sample farms, the model represents the total EU-15 farm population (as covered by the FADN data) (SEPALE webpage, Henry de Frahan et al., 2007).

Implementing decoupled measures

The single farm payment scheme is modeled as follows. A set of variables $\mathbf{a}_f$ is defined to represent the maximum eligible area that can activate the per ha single payment entitlement. There are two constraints: (1) one preventing the total single farm payment from exceeding the reference amount of direct payments and (2) another restricting the per hectare single farm payment entitlement to the eligible area.

The initial profit function

$$Z_f = \mathbf{p_f}'\mathbf{x_f} + \mathbf{a_f}'\mathbf{Subs_f}\mathbf{x_f} - \mathbf{x_f}'\mathbf{Q_f}\mathbf{x_f}/2 - \mathbf{d_f}'\mathbf{x_f}$$

where:

$\mathbf{x_f}$ (n x 1) vector of production quantities with n production activities,

$\mathbf{p_f}$ (n x 1) vector of output prices per unit of production quantity,

$\mathbf{Q_f}$ (n x n) diagonal matrix of quadratic cost function parameters,

$\mathbf{d_f}$ (n x 1) vector of linear cost function parameters,

$\mathbf{a_f}$ (n x 1) vector of technical coefficients determining how much resource base (land or animal) is needed per production quantity $\mathbf{x_f}$,

$\mathbf{Subs_f}$ (n x n) diagonal matrix of subsidies per unit of resource base,

$\mathbf{f}$ index of farms

is extended by the direct payments to:

$$Z_f = \mathbf{p_f}'\mathbf{x_f} + aa_f\mathbf{a_{f0}}'\mathbf{Subs_{f0}}\mathbf{D_f}\mathbf{x_{f0}}(\mathbf{a_{f0}}'\mathbf{x_{f0}})^{-1} + \mathbf{a_f}'\mathbf{Subs_{f0}}(\mathbf{I}-\mathbf{D_f})\mathbf{x_f} - \mathbf{x_f}'\mathbf{Q_f}\mathbf{x_f}/2 - \mathbf{d_f}'\mathbf{x_f}$$

where:

$\mathbf{D_f}$ (n x n) diagonal matrix with the production decoupling ratio of activity j,

$\mathbf{I}$ (n x n) unit matrix

$\mathbf{Subs_{f0}}$ (n x n) diagonal matrix of subsidies per unit of resource base in reference situation,

$\mathbf{x_{f0}}$ (n x 1) vector of production quantities with n production activities in reference situation,

$\mathbf{a_{f0}}$ (n x 1) vector of technical coefficients determining how much resource base (land or animal) is needed per production quantity $\mathbf{x_f}$ in reference situation

The above specification ensures that when the decoupling ratio is equal to 1 (full decoupling), the direct payments can be maximized by planting eligible crops until the level of $\mathbf{a}_f$.

The model is calibrated and run for a FADN sub-sample of 159 arable and cattle farms for which data are available for the year 2002. Simulations with SEPALE show that under the MTR of Agenda 2000 and assuming full decoupling of the direct payments, $\mathbf{D_f} = \mathbf{I}$, farmers will substitute crops that were not subsidized before the MTR for crops that were subsidized before the MTR. This substitution effect is larger for previously subsidized crops such as wheat and barley than for previously subsidized fodder crops such as fodder maize. For the former, the decline reaches 7% while, for the latter, the decline reaches 5% for the full decoupling scenario compared to the reference period of 2002. Substitution among fodder crops is tighter as a result of the feeding constraints in SEPALE and few alternative fodder crops. Effects of the MTR on allocation of non eligible crops are limited. The model is also capable of considering modulation and the transfer of direct payments with or without land (Henry de Frahan et al. 2007). Because of the non-representativeness of this sub-sample, one has to be careful to extrapolate the calibrated parameters and the simulation results to the whole sector.

5 Application: more detailed comparison of CAPRI and DRAM

Different studies report comparisons of the effects of 2003 CAP Reform for European agriculture as calculated by the different agricultural sector models (Balkhausen et al., 2008; Rude, 2007). In most cases the effects on production are considered small, but the different models can give quite different results. The 2003 CAP Reform still allowed coupled income support. Moreover, land need to be kept in good agricultural practice to be eligible for the decoupled income support. This means that the analyses of the 2003 CAP Reform is complex and what is exactly taken into account in the different studies and how is not always clear. This hampers the comparison of model results.

To further demonstrate the mechanisms of full decoupling in some selected agricultural sector models discussed above, CAPRI and DRAM are applied and selected results are compared. The lowest aggregation level of the CAPRI version used in this study is the agricultural activity at the regional farm level (NUTS2). As stated above, the decoupled payments in CAPRI are modeled as a direct payment linked to land available on the regional farm. In the reference scenario direct payments are assumed decoupled from production and the amount paid is the same regardless of how the land is used, as long as it is not completely abandoned. Here it is important to note that CAPRI distinguishes an intensive (relative high output and input use per hectare or head) and an extensive (relative low output and input use per hectare or head) technology per activity to produce the same type of output. In the reference scenario the per hectare direct payment is paid as a regional farm payment and equal per hectare per activity and technology.

The lowest aggregation of DRAM also is the agricultural activity at the regional farm level (NUTS2). DRAM distinguishes between different land use classes. The land use classes should represent different type of farms. Individual activities in DRAM are linked to the above mentioned land use classes. Next, the total amount of decoupled payments per group of activities per region is divided by the total acreage of the corresponding land

use class per region. As a result within a region the decoupled payment can be different per hectare per land use class (see table 4). DRAM does not include different technologies for the different individual activities.

Table 6 shows some selected results of a full abolition of the direct income support of CAPRI and DRAM. As can be seen results can be quite different. In CAPRI abolition of the direct payment results into a strong decrease in land allocated to cereals and the acreage of abandoned land increases sharply. Land abandonment is not included in DRAM. Like the version of CAPRI used in this study, DRAM contains a separate land balance for arable crops (excluding fodder maize). As land abandonment is not included and as all arable crop activities receive the same payment in the reference scenario (table 4), the impact of abolition of the direct payment on land allocated to the different arable crop activities is zero in DRAM. With respect to grassland the land allocated to the intensive grassland technology on the regional farm increases in CAPRI, while the land allocated to the extensive grassland technology decreases. The total acreage of grassland is fixed in the version of CAPRI used in this study. CAPRI predicts that due to the full abolition of direct payments, less land will be allocated to low productive land and more land will be abandoned. The number of dairy cows is unaffected as the decoupled direct payment is linked to land on the regional farm and not to animals.

As said before, activities in DRAM are linked to different land use classes and the direct payment is different per land use class per region. Land allocated to the different land use classes is endogenous. Moreover, number of dairy cows per hectare, milk production per dairy cow and milk production per hectare is fixed for eight land use classes. This means that affectively the direct payment is not only linked to land but also to the dairy cows. As a result, table 6 shows that due to the full abolition of the direct payments the number of dairy cows in DRAM decreases with about 3%. DRAM also includes a separate land balance for fodder maize and grassland. Table 6 shows that the hectare of grassland increases with about 0.4%, while the hectare of fodder maize decreases with about 1.6%.

Overall, DRAM shows a shift in land use from the class of high milk production per hectare to the class of low milk production per hectare grassland. At regional and sectoral level this leads to more extensive use of agricultural land.

To conclude the different land use classes representing different types of farms are lacking in CAPRI, while the different technologies per individual activity and land abandonment is lacking in DRAM. From the one hand, DRAM predicts a shift from land use class "high milk production per hectare" to "low milk production per hectare" and a decrease in the number of dairy cows. From the other hand, CAPRI predicts that within a land use class (or farm) the relatively less productive land will be left abandoned and the average yield on the remaining land will increase.

Table 6. Impact of full abolition of direct payment on land use and number of dairy cows in 2020 in the Netherlands. Percentage difference compared to a reference.

Activities	CAPRI	DRAM
Cereals	-6.9	0
Potatoes	1.3	0
Grassland intensive	+1.8	n.a.
Grassland extensive	-1.9	n.a.
Grassland total	0	0.4
Fodder maize	-0.9	-1.6
Dairy cows (heads)	0	-2.8

6 Conclusions

The paper summarizes theoretic and empirical evidence of the production effects of decoupled payments. With respect of the empirical evidence of the production effects of decoupled payments it is concluded that these are in general very small. The exception is the effect of decoupled payments on land markets. Decoupled payments tend to be capitalized into higher land values which increase land rents and prices. This in turn could lead to more land remaining in agricultural use.

The main focus of the paper lies on the implementation mechanisms of decoupling in different economic agricultural sector models. For this purpose 12 models are reviewed. A general result of the exercise is that it is very difficult to find (recent) reliable information on the models' structure let alone the implementation mechanism of decoupled payments as comprehensive model descriptions are broadly (but with exemptions) not available. Neither are (peer-reviewed) publications. In order to provide an overview of the modeling mechanisms, in many cases, researchers and modelers were directly contacted. It is found that mechanisms included in econometric studies at farm level are never explicitly included in the agricultural sector models reviewed in this paper. Generally, two decoupling implementation mechanisms appear to predominate: decoupled payments are implemented either as (1) direct payments being linked to land (i.e. per hectare lump sum transfers) or (2) as decoupling factors attached to produced quantities and representing the degree of (de-)coupling of direct payments assumed by the researcher. Depending on regional coverage and resolution of the models, the different decoupling implementation schemes chosen by the Member States are sometimes difficult to include. In that respect the regional coverage of CAPRI is an advantage and CAPRI seems to be the only model that tries to take into account the different implementations of the SPS in the different countries of the EU-27 explicitly.

To demonstrate the decoupling mechanisms in the different models DRAM and CAPRI are applied. In both models the decoupled direct payment is linked to land. However, in DRAM different types of farms or land use classes and endogenous allocation of land

over farm types within a region is included. It is shown that differences in aggregation give quite different results. Especially the effect on milk production might be underestimated in CAPRI and the effect on intensity might be overestimated. From the other price changes of marketable outputs and increased intensity within a land use class is lacking in DRAM.

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Appendix 1 Abbreviations

AMTA	Agricultural Market Transition Act
BMELV	Bundesministerium für Ernährung, Landwirtschaft und Verbraucherschutz
CCP	Counter-Cyclical Payments
DARA	Decreasing Absolute Risk Aversion
FAIR	Federal Agricultural Improvement and Reform
FSRIA	Food Security and Rural Improvement Act
GAEC	Good Agricultural and Environmental Condition
MLA	Market Loss Assistance
MTR	Mid Term Review
PFC	Production Flexibility Contract
PSE	Producer Support Estimate
SAPS	Single Area Payment Scheme
SFP	Single Farm Payment
SPS	Single Payment Scheme
RM	Regional Model

Appendix 2 U.S. Agricultural Policy since 1996

Since mid-1980's and continuing through the 90 decade several important changes in U.S. farm commodity programs moved agriculture to being more market oriented (Westcott and Young, 200x)

In 1996 the Federal Agricultural Improvement and Reform Act (FAIR) was introduced. With this act most proce-contingent agricultural subsidies were removed and replaced by Production Flexibility Contracts (PFC's) or Agricultural Market Transition Act (AMTA-payments). These were lump-sump payments with few relations to farmer's production decisions or in other words fixed, decoupled payments (Key et al, 2005; Goodwin and Mishra, 2005). The intention was that AMTA payments should decline each year until the FAIR act would expire in 2002. Low prices in the end 90s and local yield shortage created the situation that ad hoc payments to farmers were introduced. These payments are called "Market Loss Assistance" (MLA's) and ought to be decoupled because they were paid based on historical crop acreages and not with current production level. On the other hand the MLA's were tied to market prices and were a response to poor market conditions.

In 2002 the Food Security and Rural Improvement Act (FSRIA) was passed through the Congress. This Act provided increases in support and the fixed direct payments were extended for another six years (Goodwin and Mishra, 2005). Also the MLA-payments were formalized into farm legislation named Counter-Cycle Payments (CCP).

There are lots of discussions going on if these payments are "decoupled" or not. These discussions can be found in Goodwin and Mishra (2005) and Key et al (2005).

"Production flexibility contract — A 7-year contract covering crop years 1996-2002, authorized by the 1996 farm bill (P.L. 104-127) between the Commodity Credit Corporation (CCC) and farmers, which makes fixed income support payments. Farmers were given production flexibility and diversification options on their contract acres not previously allowed on base acres. Each farm's total payment was the payment rate times the payment quantity for participating base acres. In exchange for annual fixed payments, the

owner or operator agreed to comply with the applicable conservation plan for the farm, the wetland protection requirements currently in law, and the constraints on growing fruits and vegetables on contract acres. Land enrolled in a contract had to be maintained in an agricultural or related activity. The law stated that not more than $35.6 billion would be paid over the 7-year period, in declining annual amounts from $5.3 billion in FY1996 to $4.0 billion in FY in 2002. The annual payments were allocated among commodities similar to historical deficiency payments, with 53.6% going to feed grains, 26.3% for wheat, 11.6% for upland cotton, and 8.5% for rice. Target prices and deficiency payments, authorized in the 1973 farm bill, were eliminated. The 2002 farm bill (P.L. 101-171, Sec. 1105) replaced this 7-year contract with an annual producer agreement (contract) required for participation in the Direct and Counter-cyclical Program (DCP)." From Womach (2005).

"Agricultural Market Transition Act (AMTA) — Title I of the 1996 farm bill (P.L. 104-127). It allowed farmers who had participated in the wheat, feed grain, cotton, and rice programs in any one of the 5 years prior to 1996 to enter into 7-year production flexibility contracts for 1996-2002. Total national production flexibility contract payments (sometimes called AMTA payments, or contract payments) for each fiscal year were fixed in the law. The AMTA allowed farmers to plant 100% of their total contract acreage to any crop except fruits and vegetables, and receive a full payment. Land had to be maintained in agricultural uses. Unlimited haying and grazing and planting and harvesting alfalfa and other forage crops were permitted with no reduction in payments. AMTA commodity support provisions were replaced by the 2002 farm bill (P.L. 101-171, Title I), a 6-year farm bill." From Womach (2005).

"Market loss payments — A designation first used in the Omnibus Consolidated and Emergency Appropriations Act, FY1999 (P.L. 105-277) to describe the $3.1 billion in emergency income support payments authorized for eligible grain, cotton, and dairy farmers.

The Act stated that such funds were to compensate farmers for the loss of 1998 income

CRS-159 caused by “regional economic dislocation, unilateral trade sanctions, and the failure of the government to pursue trade opportunities aggressively.” Similar economic emergency support payments for selected commodities were subsequently enacted in P.L. 106-78 ($6.5 billion), in P.L. 106-224 ($6.5 billion), in P.L. 106-387 ($0.9 billion), and in P.L. 107-25 ($5.5 billion). Market loss assistance to grain and cotton producers were distributed in parallel manner to the contract payments authorized by the Agricultural Market Transition Act.” From Womach (2005).

Counter-Cycle payments The CCP payments are based on historical production and are not tied to current production. The covered crops are wheat, corn, grain, sorghum, barley, oats, rice, upland cotton, soybeans, other oilseeds and peanuts. CCp’s are paid when the effective price is less than the target price. For more information see www.agpolicy.org , document “On eliminating the counter cycle payments”.

Appendix 3 Models: abbreviation, description and owner

Model abbreviation	Description	Owner/availability
LEITAP	Agricultural Trade Analysis Project	Agricultural Economic Research Institute, The Hague, Netherlands
AGMEMOD	Agricultural Member State Modelling for the EU and Eastern European Countries	AGMEMOD consortium, most EU-member states. Leading partner: Agricultural Economic Research Institute, The Hague, Netherlands
FAPRI	Food and Agricultural Policy Research Institute	FAPRI, United States
CAPRI	Common Agricultural Policy Regional Impact Analysis	CAPRI consortium. Leading partner: Institute for Food and Resource Economics, University Bonn, Germany
AGLINK	Worldwide Agribusiness Linkage Program	OECD
PEM	policy evaluation model	OECD
ESIM	European Simulation Model	Available at vTI, Braunschweig, Germany
DRAM	Dutch Regionalized Agricultural Model	Agricultural Economic Research Institute, The Hague, Netherlands
DREMFIA	Dynamic Regional model of Finnish Agriculture	MTT Agrifood Research Finland, Helsinki, Finland.
RAUMIS	Regionalized Agricultural Sector Model	Available at vTI, Braunschweig, Germany.
AROPAj	European Agricultural Supply Model	INRA, France
SEPALE	Systeem ter Evaluatie van de Politiek aangaande Landbouw en LEefmilieu	ILVO: Institute for Agricultural and Fisheries Research, Social Science Unit, Belgium